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BLASTING ROCKS.

We meet almost every day, with some fearful account resembling this:

FATAL ACCIDENT.—On the 8th inst., a young man named Henry Jenkins, at Glen's Falls, Warren county, while blasting rocks for the purpose of procuring iron ore, was fatally injured by the premature explosion of the charge. The tamping iron was driven completely through the right portion of his head, carrying away in its course a large portion of the skull and brain. He lingered in terrible agony for nearly twenty-four hours.

Who would think, after reading such a paragraph, that *all* risk of such an accident might be dispensed with, and at the same time great economy be attained? Such is the fact, and although the proper use of precautions has enabled immense works to be executed without a single accident, it is almost impossible to *compel* workmen to adopt any improvement. It is well known that when copper needles were first used, as instead of iron ones, as being less hazardous, the workmen were in the habit of throwing away the copper needles, when furnished them, and of using the old iron instrument.

The philosophy of blasting is quite deserving of study, as immense sums of money are yearly expended for gun powder, and it is worth while ascertaining whether the maximum effort is attained for the weight of powder used, and what is still more important, whether the minimum has been attained in the yearly loss of life.

A wire suspension bridge is to be built over the Schuylkill at the Fairmount Water Works, Philadelphia. Mr. Ellet, engineer, is the contractor. It is to be finished by January next.—*N. Y. Standard.*

It is seldom that so short a paragraph has given us so much plea-

sure. The causes which have delayed the action of the proper authorities are unknown to us—but now we hope no further impediment will interfere with the immediate execution of the work. Mr. Ellet has always had our best wishes and hopes in his efforts to introduce this beautiful and economical style of bridge building. We want but one fair specimen to lead the way for hundreds of others,—we say hundreds, for we have no doubt that there are hundreds of locations where circumstances would indicate the propriety of erecting suspension bridges. The specimen we are about to have, will no doubt, do credit alike to the city of Philadelphia and the contractor.

PUBLIC IMPROVEMENT IN CANADA.

Lord Sydenham, the new Governor General of Canada, at the opening of the United Parliament, holds the following language in regard to public works:

Many subjects of deep importance to the future welfare of the Province demand your early attention, upon some of which, I have directed bills to be prepared, which will be submitted for your consideration.

Among them, first in importance at the present juncture of affairs, is the adoption of measures for developing the resources of the Province, by well considered and extensive public works. The rapid settlement of the country—the value of every man's property within it—the advancement of the future fortunes, are deeply affected by this question.

The improvement of the navigation from the shores of lake Erie and lake Huron to the ocean—the establishment of new internal communications in the inland districts, are works requiring a great outlay, but promising commensurate returns. To undertake them successfully, large funds will undoubtedly be required, and the financial condition of the Province, as it stands at present, would seem to forbid the attempt. But I have the satisfaction of informing you, that I have received the authority from her Majesty's government to state, that they are prepared to call on the Imperial Parliament to afford their assistance towards these important undertakings. In the full belief that peace and tranquility will be happily re-established in this Province, under the constitution settled by Parliament, and that nothing but a relief from its most pressing difficulties is wanting to its rapid advancement to prosperity, they will propose to Parliament, by affording the guarantee of the Imperial Treasury for a loan to the extent of no less than a million and a half sterling, to aid the Province for the double purpose of diminishing the pressure of the interest on the public debt, and of enabling it to proceed with those great public undertakings, whose progress during the last few years has been arrested by the financial difficulties. I shall direct a measure to be submitted to you em-

bracing a plan for this purpose, and I shall lay before you, for your information, and that of the people of Canada, extracts from the despatches which convey to me this most gratifying assurance.

THREE GREAT RAILWAY ROUTES FROM NEW YORK CITY TO LAKE ERIE.

We resume our remarks upon the second of these routes, the New York and Erie road, where the same were discontinued in a previous number, viz. at that period in its history, when by an act of the legislature, it was authorised to use the credit of the State in aid of its construction to the amount of three millions of dollars. This act was passed during the session of 1836, and encouraged the company to prosecute the work with renewed energy—accordingly the Engineer department was reorganized in the spring of that year, by the appointment of E. F. Johnson, Esq., and Capt. Talcott, to the former of whom was assigned the charge of the eastern division of the road, extending as far west as Painted Post, 314 miles, and to the latter, the western division, embracing the remainder of the distance to lake Erie, 170 miles. Under this arrangement, the services of Judge Wright were continued as consulting engineer.

The examinations, which had been some time in progress, were continued by these gentlemen, with a view to a definitive location of the road, and at the close of the season, Mr. Johnson made a report in detail of so much of his division as lay between the Hudson river and the Shawangunk ridge, a distance of about 60 miles. A similar report, was also made by the engineer of the western division of the portion of the road nearest to lake Erie.

The views of Mr. Johnson, relative to the most suitable location for the eastern division of the road, differed in many respects, from those previously given by Judge Wright. The reports upon this subject, have never been presented to the public. It is proper here to state, that the opinions of the former gentleman were approved by the then Board of Directors.

Mr. Johnson, in his examinations in Sullivan county, west of the Shawangunk ridge, became satisfied of the impropriety of attempting to carry the road through the interior of this county, as recommended by Judge Wright, in preference to following the valley of the Delaware river; thus increasing the total rise and fall full 1600 feet, without any probable saving in distance or expense. He accordingly caused examinations to be made upon the only questionable portion of the route, leading from the Shawangunk ridge to Carpenter's Point, on the Delaware, which showed, that by adopting that route, the advantages above enumerated would be attained, and in addition thereto, the tunnel at the ridge be avoided

—the maximum grade of 90 feet per mile, reduced to 50 or 55 ft., and the line placed in a position to develope much more completely the resources of the country, and thus secure to the road, ultimately, the greatest amount of business.

Mr. Johnson also became satisfied, from examinations made between the Delaware river and Binghamton, that the route which had been selected ought not, under any circumstances, to be adopted, being clearly of opinion that the road should be carried by the way of the great bend of the Susquehanna, thus lessening, very materially, the distance, the expense, and acclivity and extent of the maximum grades, and diminishing the aggregate rise and fall, about 1100 feet.

Mr. Johnson also invited the attention of the company to the subject of the best width of track for the railroad, and gave some reasons for exceeding the width previously adopted, and with reference to which the grading which was then in progress on the Delaware, was being executed.

In the spring of 1837, the great revulsion took place in the monetary affairs of the country, and the New York and Erie Company, like many others, deemed it necessary to suspend operations. They accordingly disbanded their engineer corps, and effected a settlement with the contractors, who were then engaged in the grading of forty miles of the road along the Delaware river, being the only portion of the road which, up to that time, had been under contract, and which was then about two-thirds completed.

In effecting this settlement, large advances, it is understood, were made by the house to which the president of the company, Jas. G. King, Esq., was attached—whereby the engagements of the company were fully met, and its credit sustained.

Although the construction of the road was thus discontinued, the friends of the enterprise did not relax their efforts in its behalf. The subject was discussed in the public journals, and meetings held in various places. A general convention was also held at Elmira, at which the present Governor of the State, was chairman of a committee to prepare an address to the public, setting forth the great merits and importance of the work.

During the session of the legislature in 1838, a report was made by engineer Johnson, in which the general subject of railways was fully discussed—the principles of their operation investigated, and applied to the case of the New York and Erie railroad. This report, was published by the legislature, in connection with one from a committee of that body, and an act was soon after passed, altering the conditions upon which the loan of three millions of dollars

was to be made available to the company, the new conditions requiring that the company should first put under contract ten miles at each end of the road, after which they were to receive from the State the loan of $3,000,000, in sums of $100,000 each, the payments to be made whenever a like amount should be raised from the stockholders, and expended upon the road.

In the spring of this year, the company, in order to avail themselves of the provisions of this act, appointed resident engineers to superintend the ten miles which was first to be put under contract, at each extremity of the road. Surveys were also made during the season on the middle or Susquehanna division, with a view to the location of that part of the road.

By request of the commissioner, engineer Johnson visited Dunkirk, and after examining the ground in that vicinity, suggested a change in the location of the road from the lake to the summit, which, it was found, would reduce the cost of construction, and lessen the maximum grade from 70 to 60 feet per mile. This change he recommended from a conviction of the impolicy of exceeding 60 feet per mile, when it could possibly be avoided, with a view to ensure certainty and safety, and the most economical use of the locomotive power, and also on account of his conviction, from a full knowledge of all the ground, that if the best route was selected for the road, there would be no occasion for exceeding the maximum of 60 feet in the grades of any other portion of the line.

The surveys and examinations were continued under the general supervision of the agent of the company, throughout this, and the following season, and portions of the line were put under contract. Upon one portion, the Susquehanna division, embracing a distance of 117 miles, the plan of founding the road upon piles, has been adopted, under circumstances which will probably enhance very much the cost of the road, beyond what it would have been, had it been graded in the usual way.

During this period, Eleazar Lord, Esq., of Tappan, was elected to the presidency of the company.

In the session of 1840, the legislature made a further change in the conditions of the loan, previously authorised, by allowing the company two dollars for every dollar raised from the stockholders and expended upon the road.

This gave a new impetus to the action of the company, and during the year nearly the whole of the remaining portion of the road was put under contract, the conditions of the contracts requiring the contractors to receive pay in the stock of the company, to the extent of one-third or three-eighths of the amount of their contracts.

Toward the close of the year, the company, it is said, appointed a chief engineer. We have seen no public announcement of this fact, and the report of the president and directors of the company, to the stockholders, recently published, is silent upon the subject. This report, which was issued in February last, is entitled, the *second* Report, and appears after an interval of more than five years from the date of the first.

Our comments upon it will be deferred to the next number.

NOTES ON THE STEAM NAVIGATION UPON THE GREAT NORTHERN LAKES.—*By L. Klein*, Civil Engineer.

Continued from page 302.

The communication between the extreme ports of the upper lakes, between Buffalo and Chicago, is maintained by steamboats of the largest class, of which, in 1839, the "Illinois" and "Great Western," were the most prominent and favored. Often passengers would prefer to wait several days at Buffalo, Detroit, or Chicago, in order to take passage in one of these two steamers. The "Great Western," was unfortunately destroyed by fire at Detroit, on the 1st of September, 1839. She was built differently from the other lake boats, and more resembling the steamers of the western rivers. The room below deck was used exclusively for freight; the machinery, ladies' cabin, and deck passengers' cabin, were upon the lower; the gentlemen's cabin and state rooms, upon the upper deck. She was of 800 tons burden, and cost $100,000.

The "Illinois," is regarded as the best finished, and largest boat, upon the lakes. Her cost was $120,000, including the engine, for which $45,000 were paid. She is likewise a new boat, having made in 1838, only a single trip. The dimensions are given in page 238. The diameter of the cylinder of the steam engine is 56 inches, the stroke, 10 feet.

The time allowed for each trip from Buffalo to Chicago, and back, is 16 days, and the distance between the two cities, in the line the boats are now running, is 1000 miles. The "Illinois," generally, requires for a passage up, (to Chicago,) 5 days, and for a passage down, (to Buffalo,) 4 days. This is at the rate of 250 miles per day, or 11 milles per hour, including stoppages. If for the latter, 12 hours are deducted, there remains for 1000 miles, only 84 hours, corresponding to an average speed of 12 miles per hour.

A cabin passenger, pays for a passage between Buffalo and Chicago, $20; a deck passenger, pays only $10; the fare between Detroit and Chicago is, for a cabin passage, $16; for a deck passage, $8. The charges for freight, are: for heavy goods, 62½ cents, per

cwt.; for light goods, 87½ cents, per cwt. A cabin passenger, pays, therefore, 2 cents per mile, including board; a deck passenger, 1 cent. per mile; and the charges for freight, are on an average, between heavy and light goods, at the rate of 1½ cents per ton, per mile.

Up to August, 1839, (when these notes were collected,) the "Illinois" had made seven circular trips between Buffalo and Chicago, and earned, at an average per trip, (of 2000 miles,) $5000. Two-thirds of the receipts were from passengers, and one-third for freight. This income appears very great, but it may be remarked here, that a great deal more has often been earned by a steamboat on a single voyage to Chicago, and back. In 1836, the then largest steamer of the lakes, the "Michigan," brought in one voyage, over $14,000. Less popular boats, have on the contrary, a far smaller income than the "Illinois," and also derive the same, nearly one-half from passengers, and one-half from freight.

The expenses of running the "Illinois," were stated to be per trip, (of 2000 miles,) $2,600, or rather more than one-half of the gross receipts. The largest item, is the cost of fuel; the consumption being 500 cords of wood, at $2, per cord. The salaries of captain and crew, which latter consists of not less than 40 individuals, also constitute a heavy item in the expense of running the boat. To the $2,600, we must again add the proper sum for general depreciation, amounting, per annum, to $\frac{120,000}{10} = \$12,000$. If 13 trips are made by the boat per year, the depreciation per trip will be $\frac{12,000}{13} = \$923$, and this added to the above $2,600, gives $3,523, as the total expense of running the "Illinois" 2000 miles, equal to $\frac{3523}{2000} = \$1\ 76$ per mile of travel.

The boarding of 60 passengers, (about the average number per trip,) during nine or ten days, may be calculated to cost about $423 dollars, and the actual cost of running the boat 2000 miles, is therefore $3,100, being per mile of travel, $\frac{3100}{2000} = \$1\ 55$.

The nett income per trip, was 5000—3523 = $1477; for the whole year, if 13 trips were made, $1477 \times 13 = \$19,201$, which is 16 per cent. of the capital invested.

The smallest of the steamers, which make regular passages between Buffalo and Chicago, is the "United States," of 367 tons burden. She has a high pressure engine, with a 28 inch cylinder, and 7 feet stroke, built at Pittsburg, similar to those used for the

boats upon the Ohio and Mississippi. The "United States" travels much slower than the other boats, and is therefore chiefly used for the freight business. She requires six days for a trip from Buffalo to Chicago, and generally goes at the rate of 7 miles per hour. The captain of this boat stated, that the average daily current expenses, amount to $120, when the boat is running, and to $40, when she is at rest. This would make, for a trip to Chicago and back:

12 days, (running) at - - - -	$120	$1440
4 days, (resting) at - - - -	40	160
Total, per trip, - - -		$1600

The expenses, per mile of travel, are, therefore, only $\frac{1600 \times 100}{2000} =$ 80 cents; comprising, however, nothing for general depreciation: and including the expenses of boarding the cabin passengers. As both will amount to about the same per trip, the 80 cents may be considered as the actual cost of running the "United States" one mile.

According to the above calculation, whe have:

Name of steamer.	*Tonnage.*	*Expense per mile of travel.*	*Expense per ton burden per mile.*
Illinois,	800	155 cents	0.194 cents.
Erie,	500	111 "	0.222 "
United States,	367	80 "	0.218 "
	1667	346 cents.	0.208 cents.

It therefore appears that the cost of running steamboats upon the lakes, was, in 1839, near *one-fifth of a cent. per ton burden per mile.* It would, however, be necessary to have similar data from a greater number of steamboats, to obtain more correct and more general results in this respect. It may be presumed that steamboats of a small tonnage are more expensive to run, and that the above result will only be found true between certain limits,* say with boats of 300 to 800 tons burden; provided, at the same time, that the power of the engine is always proportioned to the tonnage of the vessel.

Most of the large steamers upon the upper lakes, were built in 1837 and 1838, probably in consequence of the unusual increase of business in 1836, and it having been ascertained, that with a moderate traffic, a good profit may be realized from the running of steamboats. But as the number of steamers had increased faster than the traffic, the latter was not sufficient in 1838, to occupy all

*And also for routes of great length.—*Ed.*

of them. This gave rise to a great competition, and in consequence, to a reduction of prices for passage and transportation, below the amount required to defray the expenses of running. Thus, for instance, the boats took cabin passengers from Buffalo to Detroit for $4, including board, which is at the rate 1 1-9 cent. per mile; and in the same proportion, the charges for freight had gone down. In order to obviate, for the future, a similar state of things, attended by a general loss to all the steamboat proprietors, an association was formed on the 1st of June, 1839, by the owners of thirty steamboats, the object of which was: to establish regular lines of steamboats between Buffalo, Detroit, and Chicago; to employ for this purpose. as many boats as may be required to accomdate the existing travel and freight business, and to lay by the remainder; finally, to fix a regular tariff for the conveyance of passengers and freight, to which all the steamboat proprietors, forming the association, shall be bound, and which would be high enough to insure a good profit.

As it may be of interest to know the principles and engagements upon which this association was founded, I give the following brief extract of the principal paragraphs of the agreement:

1st. The affairs of the Association are conducted by a board of directors, residing at Buffalo, who superintend the whole operations, fix the number of trips, the times of departure, number of boats to be employed, from time to time, etc. At all the other ports, agents are appointed, who have to watch the interest of the association.

2d. Each steamboat represents a certain number of shares, proportioned to its actual value. The steamboat "Illinois" was put down with the largest number of shares, viz. 80; then followed the "Great Western," with 70, the "Buffalo" with 70, the "Erie" with 68, etc., etc. With the smallest number of shares, are noted the "Pennsylvania," (with 38,) the "Lexington," (37,) "Monroe," (33,) "Charles Townsend," (27).

3d. The directors have to arrange it so that all the boats belonging to the association, are as much as possible, equally occupied; and the owners have, on their part, to see that the respective boats are ready for starting, when it is their turn. If a boat misses a trip, her owner has to pay ten dollars per share, (or is charged that amount,) if the destination is Detroit, and a greater amount in proportion to the distance, if her destination was Chicago.

4th. Each proprietor defrays all expenses of running his boat, as formerly. Of the gross receipts from each voyage, 15 per cent.

are to be paid into the general fund, on the arrival of the boat at Buffalo; for the remainder, the owner of the boat is charged in the books of the association; the captain, having always to deliver a copy of his way-bill to the directors, on finishing his trip. At the end of every month, the accounts are settled; the whole gross income (after deducting the 15 per cent. paid into the general fund for the general expenses of the association,) is divided among the owners of the boats, accordlng to their respective number of shares. Those who had a greater income than they are entitled to, have to pay over the surplus, which is received by those whose income fell short of the amount, corresponding to their number of shares.

5th. For the boats going to Chicago, a deduction of 5 per cent. of the gross income is allowed to the owners, on account of the greater risk; after paying 15 per cent. to the general fund, they are charged only with 80 per cent. of the gross receipts.

6th. If 15 per cent. of the gross income should not be found sufficient to cover all the general expenses of the association, the steamboat proprietors have to supply the defficiency, by paying a certain amount for each share. The directors may fix penalties for non-compliance with the provisions of this agreement, and are authorized to receive new parties, as members of the association.

This agreement resembles, in many regards, the one which was made in 1838, among the several transportation companies, owning lines of canal boats upon the Erie canal; with the difference, that the latter divide the *nett profit*, according to the number of shares assigned to each party; while the proprietors of the steamboats divide the *gross receipts*. Both associations have attained their object; which is, to prevent opposition and its injurious effects, for the pecuniary interests of the boat proprietors. The public, on the contrary, must be losing for the same reason; as canal and steam navigation are thereby made a monopoly, like the transportation upon railroads.

In the summer of 3839, in consequence of the arrangements made by the board of directors of the association, two boats started daily from Buffalo for Detroit, one in the morning, and one in the evening; the one being intended principally for carrying freight, the other for passengers, although both were receiving freight and passengers at the same rates. Every second evening the boat which left Buffalo for Detroit, was also to continue its passage to Chicago. As formerly mentioned, the time allowed for a trip to Detroit, and back, was six days; and for a trip to Chicago and back, 16

days; the number of boats required for the trade between Buffalo and Detroit, was, therefore, 6 × 1 1-2 = 9; and between Buffalo and Chicago, 16 × 1-2 = 8; total number, 17; this shows, that of the 30 steamboats belonging to the association, only 17 were regularly employed, while 13 remained in the ports; and as the profits were divided among all, they will hardly have amounted to more than 8 per cent. of the cost of the steamboats.

The expenses of running a *canal boat* of about 60 tons burden, are, upon the Erie canal, as well as upon the Ohio canal, very near 40 cents per mile, *exclusive* of tolls; these 40 cents comprise the cost of traction, the salaries of captain and crew, the repairs and depreciation, and all other incidental expenses. We have seen that the expenses of the steamboat "Illinois," are 150 cents, of the "Erie," 111 cents, and of the "United States," 80 cents per mile of travel; the cost of running a steamboat upon the lakes, is, therefore, according to its size, only from two to four times as great, as that of running a canal boat. If we take into account also, the *toll* paid on canals, and which amounts to about 30 cents per mile, if the boat be loaded with 25 to 30 tons only, we see that it will not be more expensive to run a steamboat of 300 tons burden upon the lakes, than to run a canal boat upon either the Erie or the Ohio canal.

In regard to *railroads*, experience has shown that the expenses of working them average about one dollar per mile per train. The same expenses are increased by running a steamboat of 400 to 500 tons burden upon the lakes. Such a steamboat generally takes a greater load than a railroad train, and at the same time, as the capital invested in steamboats is comparatively small, a small surplus of receipts over the expenditure will suffice to pay a good interest; while the railroads in the United States require the gross income to be twice as great as the expenditure, in order to yield a handsome dividend. If, therefore, railroad lines and steamboat routes, are of the same length, the transportation by steamboats will be cheaper than by railroads.

The *Ohio railroad*, for instance, located along the southern shore of lake Erie, and now in progress of construction, will, during the season of navigation, hardly be able to compete with the steam navigation upon lake Erie. But the railroads projected in Michigan and Ohio, to connect lakes Erie and Michigan, will be at least three times shorter than the steamboat route over lakes St. Clair, Huron, und Michigan, and the transportation upon them, will therefore, be cheaper than by steamboats; the more so, as goods are nearly al-

ways insured, if forwarded by the latter. Passengers will generally prefer to travel by railroads, even at a higher fare, on account of their being more safe and expeditious than steamboats.

U. S. ENGINEER DEPARTMENT AND PUBLIC DEFENCE.

The following extracts from the report of the Secretary of War, will be found to contain such portions of that document as are calculated to interest our readers, in professional matters:

The many weighty considerations which invite the immediate attention of Congress to the subject of the public defences generally, and particularly to the works absolutely necessary to the security of our great commercial emporiums, and the keys to our most valuable resources of every kind, must be so generally understood and appreciated that nothing this Department can urge could add any thing to their force and conclusiveness. To say nothing of the destruction of property, and our weakened condition in a military point of view, attendant upon the carrying of any of our most assailable points, the penetration of our territory and the seizure of even one of our strongholds by a powerful enemy upon the sudden outbreak of war, it would seem to be equally the dictate of patriotism and wisdom to make due provision against the infliction of such insults to the national honor and character.

It has been urged as an objection to the further progress of the works heretofore projected for the defence of our extensive sea coast, that the recent experiments in the use of steam power in ocean navigation, and the ready application of the same powerful agent to the defence of our principal harbors, together with the late inventions in the means of increasing the destructiveness of shells, must soon introduce an entire change in the system of coast defence, as well as of maritime war in general. It is true that the mental activity, characteristic of the age in every other art and science, has not been less fruitful in suggesting improvements in the art of war, the value of some of which has already been tested in practice, and doubtless others will, in time, prove equally successful. In no department of public affairs may the natural connection and dependence between all the sciences and inventions of art be more beneficially illustrated than in the improvement of the means of national defence. That the cause of humanity will be promoted in proportion as the existing systems and means of defensive warfare are perfected by new improvements, in affording to all nations greater security to the independent enjoyment of their own acquisitions and forms of society and government; in putting the weak upon a more equal footing with the strong; in rendering wars less frequent, and allowing all the arts of peace to flourish in uninterrupted vigor, cannot be doubted. It is a source of much gratification to observe that several gentlemen of high professional distinction in the army are employing themselves in these appropriate studies. But while, in carrying forward the plans devised in former years, due regard should be had to the improvements already introduced in the means of defence, and, as far as practicable, to such modifications as may be rendered necessary by future discoveries, we must take care, by the most efficient application of the means already known and approved, not to lose the advantage of present security.

The array of well-authenticated facts and results of past experience, and the well sustained reasoning founded upon them, exhibited in the report of the board of officers referred to in the accompanying letter of the Chief of the Corps of Engineers, appear to be conclusive in favor of completing

the system of defence therein recommended, so far, at least, as to place the country in what is denominated a *good* state of defensive preparation against any sudden occurrence of war. To this extent the completion of the works heretofore projected may be regarded as indispensable, however defective they may be as a perfect system of national defence. It will be seen from the estimates stated in the report alluded to, that to effect that object will require an appropriation of $9,793,547 upon the fortifications, $2,493,000 for the armaments; making together the sum of $12,186,547. The obligation of the government to apply this sum to the objects contemplated as speedily as the nature and due permanence of the several constructions will admit, is rendered imperative and absolute by every consideration of public safety and public honor.

It is estimated by the chief engineer that the sum of $1,435,500 can be judiciously and most beneficially applied upon these essential works of defence during the remainder of the present year, in addition to the appropriations heretofore made for the same objects. The expenditures in this branch of the service have been more considerable in the current quarter than usual, and hence the additional appropriations asked for are larger than they would have been under ordinary circumstances. How this has happened will be explained by the fact, that soon after the accession of your immediate and lamented predecessor, all the means at the disposal of this department were directed to be employod upon the fortifications and other works for the protection ot the Atlantic frontier, in the manner deemed best ealculated to produce the greatest possible effictency in the shortest time. This course appeared to be called for by the unsettled and threatening aspect of our foreign relations. While the whole of the resources at the disposal of this department for this service were thus ordered to be applied to such unfinished works as could be made available, in whole or in part, in a reasonable time, it is proper to state, in this connection, that directions were at the same time given to supply, without delay, the works already completed with their appropriate armament.

The promptitude and liberality with which the Governor of New York and the commissioner of public lands in that State, responded to the recent application of the department to he put in possession of the works constructed on Staten Island, under the supervision and at the expense of that State, for the defence of New York harbor, deserve the thanks of the country, and should be further acknowledged by the immediate appropriation of the sum demanded as a compensation for the ground upon which they are situated. The works are regarded as of great importance to the object for which they were designed, and they are now in a course of repair and improvement, under the direction of a competent officer of the corps of engineers. The correspondence between this department and the Governor of New York, and the rport of the chief engineer, will show the terms upon which the title to this property will be vested in the United States.

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The subject of the expediency of completing the Cumberland road, and of improving certain harbors, and the navigation of certain great rivers, which may be regarded as necessary and proper, in making adequate provision for the public defence, I propose to postpone the further notice of until the stated session of Congress, as the consideration of it will involve the propriety of making appropriations for various works of internal improvement not necessarily connected with that object, and, consequently, will require more time than Congress, at its approaching session, may find it convenient to give.

At the last session of Congress, the sum of $30,000 was appropriated

to be expended, under the direction of this department, in repairing the breach in the Potomac bridge. Soon after the adjournment, an officer of the Corps of Topographical Engineers, distinguished alike for his science and practical skill, was selected to make the necessary examinations, and to report a suitable plan for the execution of the work. With what skill and accuracy he has performed this preliminary service, will appear from his report to the chief of the corps. The highest confidence being reposed in the soundness of his judgment, it was determined at once to expend no portion of the money placed at the disposal of the department for the accomplishment of so important a work upon a plan which did not promise to secure, what was held to be indispensable, its permanence and durability. From the statements contained in the report of Major Turnbull, it is obvious that the repairs, if done upon the plan which formed the basis of the estimate upon which the appropriation was made, could not stand through a single season of freshet or ice. The question was then presented, whether it was proper to commence the repairs upon the only plan which promised the requisite strength and durability, but the cost of which would far exceed the appropriation made by congress, and which, it was known to the department was supposed to be ample for the object, or wait the sanction of that body at the approaching session. The great convenience and importance of the bridge at this point, and the strong interest felt by the citizens of this district that the repairs should not be delayed, urged the immediate commencement of the work, while its questionable propriety, under the prospect of an immediate session of congress, decided the department to postpone further operations until that body should have an opportunity of acting upon the subject. The utility and importance of this bridge, not only to the citizens of this city and district, but to the carrying of the public mail, and to the southern travel at the season of the year when the river is obstructed by ice, are so generally felt and acknowleged, that I need say no more to recommend the additional appropriation required; or that the sanction of congress be given in some other form, at an early day of the session, to the making of the necessary repairs upon the only safe and durable plan which presents itself.

Another public work of great interest committed to the care of this department, deserves some notice at this time. The sum of $75,000 was appropriated at the late session of congress for clearing out the Red river raft. The large sums of money heretofore expended on this object, the high expectation indulged, after the first successful experiment, of the practicability of effecting it, the subsequent accumulation and continuance of partial obstructions, and the consequent disappointment of the public, caused the department to give its early and serious attention to the subject. Believing that congress, in making this appropriation, indulged the hope that it would be all that would be required for the completion of the work, the department, resolved that the highest degree of permanence and utility attainable by the use of the means placed at its disposal should be accomplished, directed that an officer of the highest credit for skill and judgment should proceed without delay to ascertain the nature, extent, and causes of the obstructions which interrupt the navigation of that river, and to submit a plan for their removal. That officer has not yet reported to the department. It is intended that the steam and snag boats, after being repaired, shall ascend Red river, while it continnes in a navigable state, to the point of obstruction; but it is not designed to enter upon the work until autumn. This policy, as will fully appear from the report of the chief, of the Topographical Engineers, and the accompanying letter of the superintendent, was dictated by a sound economy, if not by the necessity of the case.

REPORT OF THE ENGINEER IN CHIEF OF THE GEORGIA RAILROAD AND BANKING COMPANY TO THE CONVENTION OF STOCKHOLDERS, MAY 10, 1840.

To WILLIAM DEARING. Esq., President:

Sir.—The preliminary location of the extension of the Georgia Railroad above Madison, in progress at the date of my last annual report, was completed during the summer anb an estimate of its cost in detail furnished to the Board, from which the following synopsis is taken :

Grading and Bridging, - - - -	$581,191 80
Iron Rails and Fixtures, - - - -	363,900 00
Laying Superstructure and furnishing Cross Ties and Sills	161,000 00
Engineering, Rights of Way, Depots and unforseen contingencies, - - - - -	109,000 00
	$1,215,091 80

The length of this extension is 67½ miles making the whole dislance from Agusta to the terminus of the Western and Atlantic Railroad 172 miles which may probably be reduced on the final location near two miles. The route traced after leaving Madison, follows the ridge s eparating the waters of the Apalachee and Little Rivers to the Social Circle, whence it descends to the Alcovy River, at Colley's Bridge, it at an elevation of 70 feet, and then takes nearly a direct course to Covington, where it bends Noth West, and intersecting Yellow River a short distance adove the Decatur Road, it gradually rises to the ridge parting Yellow and Ocmulgee Rivers, which it follows leaving the Stone Mountain 1¼ miles to the right until it joins the high grounds dividing the latter from the Chatahoochee. Along these it is continued to the terminus of the Western and Atlantic Railroad, touching the South East angle of the village of Decatur. The steepest gradient upon the whole line is 7-10 *ft* per 100 feet, and radius of shortest curvature 1910 feet.

The heavy portions of the work upon this extension, to which I called your attention in my report of 1839, has in the route adopted, been partailly avoided, which will render the period necessary for its graduation less than then anticipated. Still however, the work is of that character and magnitude that it can only be accomplished economically by the expenditure of much time. The heavy work referred to is embraced within a space of 13 miles, extending from one mile East of the Alcovy to three miles West of Yellow River, and will cost for the graduation including bridges $251,000 00, leaving but $330,091 80 for the graduation of the remaining 54½ miles. About one fourth of the work upon these 13 miles, is comparatively light, and might be let at a later period than the rest; which would leave $138,000 00 as the immediate obligations, necessary to contract to prosecute the work upon the plan that I have advised in previous communications.

The importance of completing this link—connecting us as it will with a Railroad now nearly finished, extending to the navigation of the Great Western waters, at the earliest possible period and the disastrous consequences which will follow any considerable delay in its execution, must be so apparent to every stockholder in our enterprise, that I forbear to press the subject again upon their attention.

The Road is now in operation to Madison, a distance of 104 miles from Augusta. The causes which have delayed its completion to that point. it may not be inappropriate to refer to at the present time. Iron sufficient for

the whole Branch was ordered at an early date but in consequence of the high price offered for labor on ther Western and Atlantic Railroad, our heaviest sections of graduation, lying between this place and the Oconee River (upon which white hands were chiefly employed) became almost deserted, and all the efforts of the contractors to replenish their force to the desired number, proved unavailing. The progress of the work being thus retarded, it was deemed prudent to suspend for a time the order for Iron for that part of the Branch, beyond Greensboro. Early information of the condition of the work, and the necessity for a renewal of the order, was given by this department, but from causes, I believe, growing out of the deranged state of the currency, at the time,—it was deferred until too late for the Iron to be received at Savannah, before the fall in the river prevented its immediate transportation to Augusta, and the unprecedented continuance of dry, weather, during the summer and entire fall of 1839 afforded no opportunity, for its delivery until late in December following, the work was then pushed with a view to its completion to a point near Maison in season for the crop of last fall. The great freshet in may however, which swept away 450 feet of our embankment upon the low grounds of the Oconee, averaging 24 feet in height, and a temporary truss bridge 200 feet in lenth, interposed another obstacle to the accomplishment of our wishes. This c aused a delay of near two months, and in consequence I determined to place the terminus of the Road for the business operations of the season, at Buck Head; a place of easy access from the various sections of the country from whence we derive our custom. From Buck Head the work progressed steadily, opening in season for the spring business at Madison.

The great May freshet in the Oconee, attained a height unknown to that river, raising 13 feet above what had been pointed out to me as high water mark. At its greatest elevation it stood midway between the roofed floor and the bottom chords of the bridge, placing the structure in eminent peril. The waters, however, finally subsided without causing other injury to the bridge than displacing a portion of the rock work of the western abutment, allowing that end of the superstructure to be moved a few feet out of line; which was readily brought back to its place by the aid of large screws, kindly loaned to us by the President of the South Carolina canal and railroad company.

The grading of the Athens Branch is now finished, and the superstructure is progressing at a rate that will insure its completion during the present year, though its execution is attended, in consequence of the necessity of procuring the chief part of the materials from the piny woods, (a distance of from 70 to 90 miles,) with much trouble and vexation.

The cost of the unfinished work, and that for which estimates have not been returned, on both branches, including depots, and additional machinery for the whole road yet to be furnished, is estimated at $92,000.

The length of the road now in use is over 120 miles, and in the space of two months it will be extended to 133 miles. The Athens branch then terminating at or near the Lexington and Athens road, where the business will be centured during the next fall.

Concluded in next number.

RAILROADS IN ENGLAND.—A return of the passengers and receipts on the railways in England and Scotland, 29 in number, for one week in May, gives the number of 222,210 passengers, and an income from passengers and transportation of merchandize of 61,850*l*, or $296,880.

ABSTRACT OF A LETTER TO BARON A. HUMBOLDT, UPON THE INVENTION OF THE MARINER'S COMPASS.—LETTRE A M. LE BARON A. DE HUMBOLDT, SUR L'INVENTION DE GA BOUSSOLE; PAR M. J. KLAPROTH. PARIS, 1834, PP. 138.

Read before the Connecticut Academy of Arts and Sciences, by EDWARD E. SALISBURY, A. M., and published by permission of the Academy.

This is the title of a little volume, published six years ago, in which M. Klaproth, a well known orientalist, since deceased,* has given the result of researches made by him, respecting the invention of the mariner's compass.

It has been long since generally admitted, that the classic writers, though they had some idea of the attracting and propelling power of the magnet, were ignorant of its polarity, and consequently of its applicability to navigation. But the latter opinion, that the merit of this discovery is to be attributed to an Italian of the middle age, must be also abandoned. Klaproth's investigations go to prove, that our knowledge of the magnet, as well as of the magnetic needle and compass, has been derived, either directly or indirectly, from the east, and originally from China, where the earliest notices of both belong.

Should this work not have become known already in this country, a brief abstract of its most important points may not be unentertaining or without value.

The name *magnet* comes from the Greek. The most ancient Greek name for this natural production was (*Lithos herakleia,*) *stone of Heraclea,* a city situated at the foot of Mt. Sipylus, in Lydia. This city was afterwards called Magnesia, and the name of the stone, for which it was remarkable, became changed to (*Magnesios Lithos,*) *stone of Magnesia,* or vulgarly, (*Magnes,*) and (*Magnetes.*) The same name is found in the Latin, and its origin from the Greek is confirmed by Lucretius, who says:

"Quem magneta vocant patrio de nomine Graii:
Magnetum, qua sit patris in montibus ortus."

Other languages into which the name *magnet* has been incorporated, are the modern Greek, (*Magnetes,*) the German, (*magnet,*) the Hollandish, (*magneet-stein,*) the Danish, (*magneet,*) the Swedish, (*magnet,*) the language of the Grisons, in the dialect of Surselva, (*magnet,*) the Hungarian, (*magnet-ko,*) the Russian, (*magnet,*) the Polish, (*magnes, magnet,* and *magnet-kamien,*) and the Vendish of Styria, (*magnet,*) where, excepting in the modern Greek, the Latin has unquestionably been the medium of transporting the word from the ancient Greek.

Another name in use in several European idioms, as in the Greek, Italian, French, the romance language of Surset, the Bosnian, Croatian, and the Vendish of Styria, is *calamita.* This word appears to be of Greek origin, and is given by Pliny as the name of a *small green frog.* The application of the term to the magnet is explained by a fancied resemblance to that animal in the magnetic needle, when poised on water by means of small reeds, projecting beneath it like the legs of a frog in motion, according to the usual mode in early times, in Europe, of adapting it to the mariner's use. But that the idea of such a resemblance was not original in Europe, one might be led to suspect, from the analogy of the Birman name for the compasss *anghmyaoung,* which signifies *lizard,* and will be rendered still more probable by evidence, hereafter to be given, that this mede of using the magnetic needle in navigation, was adopted in China about

* M. Klaproth was a Prussian, born at Berlin in 1783, and died at Paris in 1835.

eighty years previous to the earliest mention of the needle itself in any European writer.

Many of the terms applied to the magnet, both in European and Asiatic languages, allude to one or another of its characteristic properties. Among these, the French *l'aimant, the lover*, and the Spanish and Portuguese *iman*, with the same signification, is particularly worthy of notice, as having its precise correspondent in the Chinese *thsu chy*, of which a celebrated Chinese naturalist who flourished in 1580, observes: "if this stone had a love for the iron, it would not make it come to it," and a writer of an age eight centuries earlier: "The magnet draws the iron like a tender mother, who causes her children to come to her, and it is for this reason, that it has received its name." In India also, the magnet was of old personified as capable of tender attachment, in the Sanscrit name *thoumbaka, the kisser*, from which are derived several appellations now in use in that country, as *tchoumbok* in the Bengalee, and *tchambak* in the Hindostanee. Another Sanscrit term for the magnet is *ayaskanta, the loved stone*, or *ayaskanta-mani, the stone loved by iron*, which also the Bengalee retains; and in the Cingalese the magnet bears the name of *kandako-golah, the stone that loves*, which is apparently composed of the Sanscrit *kanta, loving*, and the Cingalese *galah, stone*.

The language of Mussulman Asia derive the names which they give to the magnet, mostly, from the Greek (*Magnetes:*) thus in Arabic we find *al-maghnathis;* in Persian *sang-i-maghnathis—the stone maghnathis*, and in Turkish *miknathis*.

Of the names given to the magnetic needle and compass, one which is to be met in many European languages, is the Italian *boussola*, the Portuguese *bussola*, the Spanish *brujula*, the French *boussole*, etc. Some Italian authors have claimed this term as original in their own language, and have sought to argue, from its having been so widely adopted in other languages, in favor of their national assumption of the honor of having invented the compass. The word cannot, however, be deduced from an Italian origin any more reasonably than from an assumed English diminutive *boxel*, no such diminutive existing, which some writers have attempted; nor does the Greek *Mponsonlas* bear the appearance of being original with that language. The derivation of both the Greek *Mponsonlas* and the I lian *boussola*, and so of the corresponding words in other languages of Europe, is to be found in the Arabic *mouassala—arrow*, an initial *m* of Arabic words, having been very commonly changed, in the middle age, to *b*. *Mouassala* is itself one of the names given to the magnetic needle in Arabic.

Among the Turks and Persians, the terms for the compass, in most general use, is *kibleh-nameh*, or *kibleh-numa—indicator of the kibleh*, which is the direction to be faced in prayer, and, consequently, as Mecca lies to the south of most of the Mohammedan countries, *the south*. With this is perfectly synonymous the Chinese appellation *tchi nan—indicator of the south*, and the Mandchow *dchoulesi dchorikou*, for the magnetic needle. The Persians undoubtedly derived their name for the compass, *kibleh-nameh*, from the Chinese, for it is a peculiarity limited to the Chinese and those who have adopted their civilization, that they make the south their principal pole, regarding this as the anterior, and the north as the posterior side of the world; according to which they also place the throne of their Emperor, and the principal facade of their edifices, so as to front the south.

As the Hindoos have never been addicted to navigation, the knowledge of the compass seems to have been introduced but very late among them

and the names they give to it are for the most part foreign. In the English provinces of India it is called *compass*, from the English; and in the Cingalese of Ceylon, *kompasouwa*, a corruption of *compass*. The Hindostanee has abopted the Persian term *kibleh-numa—indicator of the south.*

In these comparisons of the most current terms for the magnet and the magnetic needle and compass, in the eastern and western world, there is not a little to lead one to believe that the discovery of the wonderful properties of the magnet originated in the remote Orient, and was gradually communicated to the nations of the west. But there are historic notices of the magnetic needle and compass, which also point to the east as the field of the first discovery of the polarity of the magnet and its applicability to navigation.

The earliest explicit mention of the magnetic needle, by any European writer, is in a political work of Guyot de Provins, dating about the year 1190. The next as to date is found in the *Historia Orientalis* of Jacques de Vitry, referring to the year 1204: "Adamas in India reperitur—ferrum occulta quadam natura ad se trahit. Acus ferrea, postquam adamantem contigerit, ad stellam septentrionalem, quae velut axis fermamenti, aliis vergentibus, non movetur, semper convertitur, unde valde necessarius est navigantibus in mari." It would be difficult to give any authority to this passage, and not recognise the east as the source of knowledge, among Europeans, of the polarity of the magnet. Not long before the year 1260, Brunetto Latini, "maitre du divin Dante," being on a journey in England, saw the magnet and the magnetic needle for the first time, in visiting Roger Bacon, and a fragment of a letter of his, written on the occasion, which has been preserved, describes them thus: "He shew me the magnet, a disagreeably looking black stone, it readily unites with iron; a small needle is taken into the hand and fastened in a bit of reed, then it is put upon a surface of water, and one stands over it, and the point turns towards the star, (the polar star;) in case the night is obscure, and neither star nor moon is seen, the mariner may keep to his right course."

Albertus Magnus, of Swabia, who flourished about the middle of the thirteenth century, quotes in a work of his, "*De Mineralibus*," a passage from a "treatise concerning stones," attributed to Aristotle, of which the following portion merits particular attention: "Angulus magnetis cujusdam est, cujus virtus apprehendi ferrum est ad *zoron*, hoc est septentrionalem, et hoc utuntur nautæ. Angulus vero alius magnetis illi oppositus trahit ad *aphron*, id est meridionalem: et si approximes ferrum versus angulum zoron, convertit se ferrum ad zoron, et si ad oppositum angulum approximes, convertit se directè ad aphron." Vincent de Beauvais, a cotemporary of Albertus Magnus, has left a similar passage, likewise quoting Aristotle, in his "*Speculum Naturale*:" "Angulus quidem ejus cui virtus est attrahendi ferrum, est ad *zaron*, i. e. septentrionalem, angulus autum oppositus, ad *aphron*, i. e. meridiem. Itaque proprietatem habet magnes, quod si approximes ei ferrum ad angulum ipsius qui zaron, i. e. septentrionem respicit, ad septentrionem se convertit, si vero ad angulum oppositum ferrum admoveris, ad apron, i. e. meridem se movebit." The names given in these two passages to the north and south pole, *zoron* or *zaron*, and *aphron*, are the Arabic, north and south. As to the work here attributed to Aristotle, under the title of a "treatise concerning stones," we have no such Greek text of this author, and it is doubtful if ever he wrote such a book. There is an Arabic treatise entitled *the Book of Stones*, composed by a certain Lucas, son of Serapion, but purporting to be a translation from Aristotle, which Baron De Sacy has shown to be the

true source of citations under the name of Aristotle, in the writings of Teifachi and Beilak Kibdjaki; and very probably Albert and Vincent have quoted this same work in the account of the polarity of the magnet. However, the names *zoron* and *aphron*, applied by these authors to the two magnetic poles, are sufficient to prove that they derived their knowledge of the magnet's polarity from an oriental source.

But there is no evidence that the Arabs were the inventors of the magnetic needle. It may, indeed, have been in use among the Arabian navigators, before it was noticed by men of science; but we have in no Arabic work any mention of it which goes back beyond the year 1242. In this year, Beilak Kibdjaki made a voyage from Tripoli to Alexandria, and in his treatise entitled *the Treasure of Merchants, touching the knowledge of stones*, he has recorded his observations on that occasion, respecting the magnetic needle. "As to the properties of the magnetic needle," he writes, "it is to be observed, that the captains who navigate the sea of Syria, when the night is so obscure that they can see no star by which to steer their course according to the four cardinal points, place a pitcher full of water in the interior of the vessel, to be sheltered from the wind, and then take a needle and pass it through a piece of wood or reed, forming a cross, which they throw into the water in the pitcher prepared for the purpose, and it floats. They then take a magnet large enough to fill the palm of the hand, or smaller, and bring it near the surface of the water, giving their hands a rotary movement towards the right, so that the needle turns about on the surface of the water. Then they withdraw their hands all of a sudden, and truly the needle points north and south. I myself saw this done on my voyage from Tripoli in Syria to Alexandria, in the year 640," (or 1242 of our era.) "They say," he continues, "that the captains who navigate the Indian ocean supply the needle and piece of wood by a sort of fish, of thin iron, hollow, and so made with them, that, when thrown into the water it floats, and shows by its head and tail the two points of north and south." So early, then, as the year 1242, the water compass was in general use on the Syrian waters, and was known, it is to be presumed, as well to Arabian as to European navigators. But what this author, Beilak, says of the peculiar form, according to report, of the magnetic needle which was used in the Indian ocean, indicates an independent knowledge of it in that quarter of the globe; and recalling the signification of *calamita, little green frog*, and the Burman appellation for the compass, meaning *lizard*, leads one to look further to the east than any of the Mohammedan countries for the original discovery of the polaric properties of the magnet. We shall presently see that between 1111 and 1117, the Chinese made a water compass exactly such as Beilak describes that which he saw in 1242, in the Syrian waters, and also like that which Jacques de Vitry saw within the first half of the thirteenth century, in the possession of Roger Bacon.

The Chinese have been acquainted with the magnet and its attractive force and polarity from the highest antiquity. In a Chinese dictionary, composed in 121, by Hiu-tchin, the magnet is mentioned, as a "stone with which one can give direction to the needle." About a hundred years later, as we learn from P. Gaubil, in his history of the dynasty of the Thang, there is found a distinct notice of the compass as an instrument by which to ascertain the points of north and south. Under the dynasty of the Tsin, (i. e. between 265 and 419,) Chinese vessels were already steered to the south by means of the magnet. But the Chinese were acquainted with the declination of the needle, also, a long while before it was supposed to be first discovered by Columbus. In a medical

natural history, composed between the years 1111 and 1117, the author gives the following notice of the magnet and of its properties. This is the most ancient *description* of the magnet found as yet in any Chinese book: "The magnet is covered over with little bristles slightly red, and its superficies is rough. It attracts iron, and unites itself with it; and for this reason it is commonly called "the stone which licks up iron." When an iron point is rubbed upon the magnet, it acquires the property of pointing to the south; yet it always declines eastward, and is not perfectly true to the south. On this account, a thread of new cotton is taken and attached by a particle of wax as large as a mustard-seed, exactly to the middle of the iron, which is thus suspended in some place where there is no wind. The needle then points, without variation, to the south. If the needle is passed through a little tube of thin reed, which is afterwards placed on water, it directs to the south, but always with a declination to the point *ping*, that is to say, east $\frac{1}{6}$ south." The accuracy of this observation, referring it to the capital city of the empire, is confirmed by P. Amiot, who, after taking magnetic observations at Peking for several years, found the variation of the needle there to be constantly from 2° to 2° 30′.

Upon a due consideration of all these historic data, in connection with the comparison of the European and Oriental names of the magnet, the magnetic needle, and the compass, it cannot appear to any one to be a rash conclusion, that the knowledge of the natural production, as well as of its wonderful applicability in navigation, existed first in China, and was communicated by the intervention of the Arabs to the nations of Europe, probably on occasion of the more frequent intercourse between Europe and the east, to which the crusades gave rise.

But before the Chinese had applied the magnet to use in navigation, it was employed among them in the construction of *magnetic cars* by which travellers on land directed their course. Not to cite those stories of the Chinese relative to these cars which lose themselves in a fabulous antiquity, the earliest historic allusion to them dates in the first half of the second century, when the Emperor Tcheou Koung, as it is related, gave to some ambassadors from Tonkin and Cochin-China "five travelling cars, so constructed as always to indicate the direction of the south. The cars which showed the south," it is added, "always went in front, to show the way to those who were behind, and to make known the four cardinal points." In the year 235, a Chinese Emperor ordered one Makiun to construct a "car which would show the south," to be deposited in a sort of Museum; and we are informed that the invention had then, for some time, been lost, and was recovered by the ingenuity of Makiun. In a book of annals of the dynasty of the Tsin, the magnetic car of a previous age is thus described: "The figure sculptured in wood, standing upon the magnetic car, represented a genius dressed in feathers. In whatever direction the car inclined or turned, the hand of the genius pointed invariably to the south. When the emperor went out in form, in his carriage, this car led the van, and served to show the four cardinal points." From the year 236, the construction of a magnetic car seems to have been a puzzle which different Chinese Emperors proposed to the ingenious men of their courts, and the knowledge of the invention appears to have been confined within very narrow limits.

Between 806 and 820, under the Thang dynasty, were first constructed cars called *Kin koung yuan*. These were magnetic cars to which had been added a sort of drum called *Ki li kou*, a piece of mechanism which may remind one of some curious public time-pieces still to be seen in old

cities of Europe. A *drum car* is thus described by a Chinese author: "It had two stories, in each of which was a wooden man holding erect a mallet of wood. As soon as the car had run one *ly*,* the wooden man of the lower story struck a blow upon a drum, and a wheel placed at the middle of his height made one revolution. After the car had run ten *lys*, the wooden man of the upper story struck a little bell."

The magnetic car cannot be traced later than 1609. In that year was published a celebrated Encyclopedia, which contains the following passage, accompanying a design of the human figure which was placed upon the magnetic car: "This is a car ornament, of which the dimensions are as follows: It is one foot and four inches in height, and in breadth at the bottom seven inches and four lines. At the extremity of the axle-tree of the car is pierced a round hole of three inches and seven lines in diameter. In this hole moves a peg of the same size, on which is placed the figure of a man sculptured in *jade*,† whose hand always points to the south. This figure had motion in the hole, and turned. In the years Yan Yeou, (from 1314 to 1320,) it was an object to determine the position of the monastery of Yao mou ngan, and the figure on the magnetic car was made use of for this purpose.—*Silliman's Journal.*

ON THE FIRST, OR SOUTHERN COAL FIELD OF PENNSYLVANIA; by M. Carey Lea.

Among the numerous sources of wealth possessed by Pennsylvania, are her inexhaustible iron mines and coal beds. It must be acknowledged by all, that they constitute her true wealth, and they will contribute greatly to elevate her in the scale of national prosperity.

Her coal beds are peculiarly valuable, possessing as she does, every variety of this fuel, from the hardest *anthracite*, to the most highly charged *bituminous coal*. She can supply those kinds most suitable for economical purposes, for generating gas, for making and working iron, in a word, for all the many uses to which this substance is applied. It is chiefly to her mines that the steam navigation of the Atlantic coast must look for its supplies, and the quantity thus consumed, though at present it may appear inconsiderable, will probably be soon enormously increased.

It has been the opinion of my father for many years, that the hard or highly carbonized anthracite of the eastern end of the southern coal field, changes to the bituminous in the western end, by nearly regular gradations, the veins probably being continuous from the one point to the other. A case analogous to this is presented to the anthracite and bituminous coal of South Wales.

With a view of testing this opinion, and for other purposes, a laborious set of analyses was undertaken, from specimens known to be authentic, in the laboratory of Prof. Booth. The method of analysis pursued was the following. One gramme of the coal, reduced to a fine powder in an agate mortar, was carefully and gradually heated, in a platina crucible having but one small aperture, in order to drive off the volatile matter. When this was effected, the residuum was weighed, and the volatile matter thus ascertained. The crucible was then exposed to the highest heat of an alcohol blowpipe for some hours, until the carbon was thoroughly burnt out, and the ash was then weighed. The ash and volatile matter substracted from 1.000 gave, of course, the carbon.

* A measure of distance variously estimated. John Francis Davis, in his *History of China*, computes thirty *lys* in one English mile.

† A hard stone, of variegated hue.

It must be borne in mind that the analyses of the various coals from the Dauphin and Susquehanna coal company's lands, were made from specimens taken from explorations of veins, near the surface, and should therefore be considered in a great measure as crop coals.

*Analyses.**

No. 1. *Lehigh.*—The farthest eastern point at which coal is worked, is that owned by the Lehigh or Mauch Chunk coal company. The specimen of this coal examined was very pure, and of very conchoidal fracture; it was broken with difficulty and flew very much under the strokes of the pestle. Its color was a deep, brilliant black, with very narrow parallel lines of a still deeper color. It was a long time in burning and left a light fleecy ash of a very white color.

No. 2. *Tamaqua.* Little Schuylkill coal Co.'s mines.—This is the next important mining station, west of the Lehigh. The specimen was very brilliant with a somewhat conchoidal fracture, and so hard that white paper rubbed on a fresh fracture was scarcely marked by it. Its ash was greyish, white, and flocculent.

No. 3. *Pottsville.* Black Mine vein.—Next in order is the Pottsville coal. The specimen examined was of a fine brilliant appearance and very refractory. It came from the Black Mine vein, two hundred feet below water level, and contained layers of a darker and softer substance without any splendor, and by these it usually fractured. Ash deep red.

No. 4. *Pinegrove.* A specimen of this coal, from the "North Seam," three-fourths of a mile north of Sharp Mountain, was submitted to examination. It was brilliant, exhibited a conchoidal fracture, and was refractory under the hammer. Ash reddish yellow.

No. 5. *Black Spring Gap,* 26 miles from the Susquehanna. Fish-back back vein.—This is the next western point at which coal is worked, and from it, specimens of two veins were examined, this and the following. This one is devoid of lustre, and after burning, leaves a yellowish red ash.

No. 6. *Black Spring Gap.* Peacock vein.—The coal from this vein was brilliant, with a conchoidal fracture, and leaves a yellowish red, very light ash.

No. 7. *Gold Mine Gap,* 25 miles from the Susquehanna. Peacock vein.—This coal is brilliant, possessing a conchoidal fracture. Its ash was yellowish red, very bulky and light.

No. 8. *Rausch Gap,* 21 miles from the Susquehanna. Pitch vein, west side.—The specimen from this vein mas rather friable. Its fracture was somewhat conchoidal, and generally brilliant. Ash yellowish red.

No. 9. *Rausch Gap.*—Pitch vein, east side.—This coal is hard and rather brilliant, leaving a deep red ash, which changes to yellowish brown by a day's exposure to the air.

It will be seen that the portions of volatile matter in the two last are very early equal. The difference in the hardness and in the ash, probably esults from the one specimen having been taken from nearer the crop than the other.

No. 10. *Yellow Springs Gap,* 16 miles from the Susquehanna. Backbone vein.—This specimen possessed but little lustre and left a dark red ash.

* The analyses have been condensed into a tabular form for greater economy of room and perspecuity; the numbers will be found to correspond with the table.—*Eds.*

No 11. *Yellow Springs Gap.* Vein next north of Central Ridge.—This is a dense, black coal, which cokes. Its ash is pale and salmon color.

No. 12. *Rattling Run Gap,* 13 miles from the Susquehanna. Perseverance vein.—The specimen analyzed was brilliant, with a clear, bright fracture, and burned with a bright flame. Its ash was dark red.

This terminates our series, being the last important coal station where a vein fit for working has been discovered, so far as exploration has gone on.

It would appear from these results, that the bituminous qualities of the coal increase with considerable regularity from Tamaqua to Rattling Run, that from Mauch Chunk being an exception, although its excess of volatile matter may probably be attributed to its containing a large proportion of water.

Specimens of two other American coals, were examined for comparison with the preceding. These were from the Blossburg or Tioga mines, and from Cumberland, Md.

No. 13. *Tioga.*—The Tioga oal field is a detached portion of the eastern extremity of the great Allegany coal basin. The specimen examined was of a medium hardness, and its fractures were sometimes brilliant, sometimes altogether devoid of lustre. Its ash was cream-colored, inclining to grey.

No. 14. *Cumberland, Md.*—This coal is brilliant, with an even fracture, and cream-colored ash, passing to grey.

No. 15. *Black Spring Gap.* Grey vein.—This remarkable vein, as mentioned by R. C. Taylor, Esq., in his "Report of the Stoney Creek Coal Estate," is about seventeen feet thick, containing much fine coal, with a vein near the centre, two or three feet thick, of coal of a greyish color, which has given the name to the whole. The specimen of this included vein, in my possession, closely resembles plumbago in appearance. It burns with little flame, leaving a yellowish red ash.

Table of analyses of coals from Pennsylvania. The numbers refer to those prefixed to the paragraphs.

No.	Locality.	Carbon.	Volatile matter.	Ash.
1.	Lehigh,	.870	.073	.057
	Another analysis of the same gave,	.869	.075	.055
2.	Tamaqua,	.910	.055	.035
3.	Pottsville,	.884	.068	.048
4.	Pinegrove,	.859	.072	.069
5.	Black Spring Gap. Fish-back vein,	.840	.065	.095
6.	Black Spring Gap. Peacock vein,	.886	.071	.043
7.	Gold Mine Gap. Peacock vein,	.830	.090	.080
8.	Rausch Gap. Pitch vein, west side,	.771	.109	.120
9.	Rausch Gap. Pitch vein, east side,	.789	.110	.101
10.	Yellow Springs Gap. Back-bone vein,	.775	.110	.115
11.	Yellow Springs Gap. Vein next N. of Central Ridge,	.747	.148	.105
12.	Rattling Run Gap,	.761	.169	.070
13.	Tioga,	.725	.175	.100
14.	Cumberland, Md.,	.754	.170	.076
15.	Black Spring Gap. Grey vein,	.860	.045	.095

A comparison between the coals of Cumberland, Md., Blossburg, Penn., Dauphin Co., Penn., and South Wales, shows a remarkable simi-

larity of composition as respects volatile matter. The greatest difference, in fact, scarcely exceeds one half of one per cent., as will be seen by the following table.

	Carbon.	Volatile matter.	Ash.
Cumberland,	.754	.170	.076
Blossburg, or Tioga,	.725	.175	.100
Dauphin,	.761	.169	.070
South Wales, Dowlais, (by Berthier,)	.795	.175	.030

We give place to the communication kindly sent us by Mr. Redfield, in hopes that engineers will give to the subject the attention it demands. No class of men is better able to collect information of a character calculated to advance the science of meteorology.

THE NEW BRUNSWICK TORNADO.—REMARKS RELATING TO THE TORNADO WHICH VISITED NEW BRUNSWICK, IN THE STATE OF NEW JERSEY, JUNE 19, 1835, WITH A PLAN AND SCHEDULE OF THE PROSTRATIONS OBSERVED ON A SECTION OF ITS TRACK. BY W. C. REDFIELD, ESQ.*

[From the Lond. Phil. Mag. and Jour. of Science. Revised by the Author.]

In a paper printed in the American Journal of Science, in which I referred to the support given by Prof. Bache to Mr. Espy's theory of storms, at the meeting of the British Association in 1838, founded upon observations made on the New Brunswick tornado, I have stated, that in my own examinations I had observed numerous facts which appear to demonstrate the *whirling* character of this tornado, as well as the *inward* tendency of the whirling vortex at the surface of the ground; and further, that the direction of rotation was *towards the left*, as in the North Atlantic hurricanes.† It was due to Professor Bache that my observations should be brought forward; a task which has been too long delayed, partly from a desire that he would revise his former conclusions. The facts now presented form part of the evidence to which I then alluded.

If the effects which I present for consideration be due to "a moving column of rarefied air without any whirling motion at or near the surface of the ground," as maintained by Professor Bache,‡ we might expect to find a relative uniformity in these effects on the two opposite sides or margins of the track. How far this is the case may be seen by inspecting the observations which are found upon the annexed plan of prostrations.

The occurrence of these tornadoes appears to have been noticed from the earliest antiquity; and their violence has been considered as the effect of an active whirling motion in the body of the tornado; this peculiarity of action having often been supported by the testimony of eye-witnesses.

The whirling motion, however, has not been recognized by Prof. Bache, Mr. Espy,§ or Prof. Walter R. Johnson,‖ in their several accounts of the New Brunswick tornado; these writers having been led to adopt or favor

* [Communicated by Sir John F. W. Herschel, Bart.] This paper was intended by its author to have been read at the late meeting of the British Association in Glasgow, but was unfortunately detained.—J. F. W. H.

† Amer. Jour. of Science, Oct. 1838, vol. xxxv, pp. 206, 207.

‡ Transactions of Amer. Phil. Society, vol. v, p. 417, New Series.

§ Trans. Amer. Phil. Society, vol. v, New Series.

‖ Journ. Academy, Nat. Sciences of Philadelphia. vol. vii, part ii.

a theory of ascending columns in the atmosphere, founded on the supposed influence of calorific expansion accompanying the condensation of vapor.

It is remarkable that previous to this period the evidences of the rotation or other characteristic action of tornadoes appear not to have been duly examined and recorded, nor even to have received the distinct consideration of scientific observers. We are, therefore, left to seek out the peculiarities of their action, by examining the direction of the prostrations and other effects of the wind; and from a careful induction from the effects which are thus registered as by the finger of the tornado, we may hope to arrive at satisfactory conclusions.

If the numerous prostrations of trees and other objects, which may be observed in the path of a tornado, be the effects of a violent whirlwind, it appears most reasonable to infer that this whirl had the common properties which may be observed in all narrow and violent vortices, viz. *a spirally descending and involuted motion* of the exterior and lower portions of the vortex, rapidly quickened in its gyrations as it approaches toward the centre or axis of the whirl, and thence continued (in the case of the whirlwind) spirally upward, but gradually expanding in its spiral course by an evolute motion in ascending towards the extreme height of the revolving mass.

If we now contemplate the action of this whirling body, while in a state of rapid progression, on the several objects found in distinct portions of its path, we may expect to witness effects of much complexity, particularly as regards direction; and, also, that amid this apparent complexity, some clue may be obtained that will serve to indicate or establish the true character of its action. Some of the effects which may be expected, or observed, will be here considered.

1. We may expect to find, in the path of the whirlwind, strong evidence of the inward or vorticular course of the wind at the earth's surface; the violence of which inward motion is clearly indicated by the force with which various objects, often of much weight, are carried spirally upward about the axis of the revolving body.

Now the effects of this inward vorticular motion at the surface of the ground, are clearly manifested in the cases before us; and are also well illustrated by Prof. Bache, in his paper on this tornado, although referred by him to a different action.*

2. As the effects which may be observed at various points in the track were produced at different moments of time, and by forces acting in different directions, as well as of various intensities, we may expect to find great diversities in the several directions of the fallen trees and other prostrated bodies; and further, as all the forces, in addition to their inward tendency, have likewise a common tendency in the direction pursued by the tornado, we may expect to find, also, full evidence of this progressive force in the direction of the fallen bodies.

These effects, I need hardly state, are distinctly observed in the case before us; and appear likewise from the observations of Professor Bache. The results already noticed have been observed also in the tracks of other tornadoes: so that a general inclination, both inward and onward, amid the various and confused directions of the fallen bodies, is distinctly recognized by all parties to this inquiry.

* Transactions of American Philosophical Society, vol. v.

3. It has been often noticed, that where two fallen trees are found lying across each other, the uppermost or last fallen points most nearly to the course pursued by the tornado.

In view of the facts above stated, much pains have been taken to establish, by induction, a central and non-whirling course in the wind of the tornado; first inward and then upward, like that resulting from a common fire in the open air. I do not propose to notice the insuperable difficulties which appear to attend this hypothesis. It is important to state, however, that all the above mentioned effects, when theoretically considered, are, at least, equally consistent with the involute whirling action of an advancing vortex. This important consideration I have not seen recognized by the advocates of the non-whirling theory; and it seems proper, therefore, to point out, as we proceed, other and more distinguishing effects of the whirling action.

4. It has been noticed, also, that the directions given to broken limbs and other bodies, by the successive changes in the direction of the wind as the tornado passed over, have been found in opposite courses of change, on the two opposite sides of the track.

This fact, too, has been strongly urged as disproving a rotary motion. But, unfortunately for the objection, this effect accords fully with the rotary action of a progressive mass of atmosphere; as is well known to all who clearly understand the theory of rotary storms.

In all such whirling masses the successive changes in the direction of the wind *result solely from their progressive motion*, and necessarily take place in opposite directions or courses of change on the two opposite sides of the advancing axis. This indication fails, therefore, as a theoretic test; and I now proceed to notice others, which are peculiar to a progressive whirling action.

5. In considering further the effects of such action, we may expect to find that the greatly increased activity of gyration which is always observed near the centre of a vortex, will be indicated by a more violent and irregular action in and near the path pursued by the axis of the whirlwind, than is found under its more outward portions.

This effect is often strikingly exhibited in the path of tornadoes; while, in the supposed ascent of a non-whirling column, it would seem that no part of the surface would be so much exempted from its action, and particularly from its power of prostration, as that lying near its centre.

6. As the effect of rotation must be to produce, on one side of the advancing axis, a reverse motion which is contrary to the course of the tornado, it is evident that on this side the prostrating power will be much lessened; that the cases of prostration, therefore, will be here less numerous; and that some of these, at least, will be produced in a backward direction, more or less opposite to the course of the tornado. By this criterion, not only the whirling movement, but the direction of the rotation also, may be clearly ascertained.

This effect is best observed by comparing the two opposite margins of the track, and is strongly exemplified in the case before us. Here we find, that most of the trees prostrated within five chains (110 yards) from the northern or left-hand margin of the track, lie in directions which are more or less backward from the course of the tornado. The prostrations in this part of the track are also for the most part less general than on the opposite side of the axis,* a greater portion of the trees being left standing.

* There was a vacant space in the belt of wood, immediately to the right of the line *c c* or axis of the tornado, owing to which the effect mentioned does not appear so obvious in the figure.

It sometimes happens, owing perhaps to the inward or involute motion having exceeded the progressive motion at a particular point, that some inclination backward will be found in the prostrations on the progressive side of the whirl, as seen on the sketch, Nos. 77 to 80. But these unfrequent cases by no means compare with the numerous backward and sometimes *outward* prostrations, found on the reverse side of the whirl, as illustrated by Nos. 1, 3, 4, 7, 9, 10, 12, 13, etc., on the left side of the track. Thus we find here a satisfactory indication that this tornado was a whirlwind; and that the course of its rotation was to the *left* in front.

7. It is also apparent, that the prostrating power of a whirlwind on the side of its reverse motion as just considered, will be limited to a shorter distance than on the opposite or progressive side of its axis.

This is seen in the more limited *extent* of the prostrations on the north or left margin of the track, as compared with the extent of those which incline inward on the right side of the apparent axis. There were many trees standing beyond the northern border of the track, but none had fallen.

8. It follows, in like manner, that on that side of a whirlwind in which the rotary motion coincides with the progressive movement, the prostrating power will not only be increased in its intensity, but will also be effective over a wider space; and that few, if any, of the prostrated bodies will be found to have been thrown backward.

In the case before us, as may be seen in the sketch, the prostrations are found to extend on the southern or right side of the apparent axis to a distance nearly twice as great as on the left side. The same general result has also been noticed in the tracks of other tornadoes which I have examined.

The facts here considered are too important to be overlooked, and seem fully to establish both the whirling action and the course of rotation.

9. If a rotative action be exhibited, the mean directions of all the prostrations, on each of the two opposite sides, will differ greatly in their respective inclinations to the line of progress, and the mean direction of those on the reverse side will be found more backward than on the opposite side, where the rotative course coincides with the progressive action.

In the case before us, the mean direction of all the prostrations on the right side of the track is found to incline 52 degrees inward from the line of progress. The course of the tornado is here taken to be east; although for the last half mile its course had been a little north of east. On the left side, the mean direction is found to be S. 3° W., or 93 degrees inward and backward; a difference in the mean inclination from the course on the two sides of 41 degrees.*

If we now take the indications afforded by the two exterior portions of the track, to the width of five chains on each side, where the effects are more distinctive in their character, we find on the right side a mean inward inclination of 46 degrees, the mean direction being N. 44° E.; while on the left side of the track the mean inclination is not only inward but 48 degrees backward, the mean direction on this side being S. 48° W. We have thus a mean difference in the inclination of the fallen trees, on the two exterior portions of the track, of no less than 92 degrees.

* The inclination of the fallen trees from the course, on both sides the axis, are reckoned inward and backward.

These indications seem conclusive, also, in favor of the whirling action in the direction from right to left.

10. Although of less importance, it should be mentioned that the diminished action of the tornado which is commonly observed on the hillsides and summits over which it passes, and the greatly increased action in the bottoms of the valleys, and even in deep ravines, afford a strong argument against ascribing the effects to the ascent of a non-whirling rarefied column; as the latter, it would seem, must act with greater force on the hillsides and summits than in the bottoms of valleys. The general correctness of the observation above stated cannot justly be questioned.

11. The sudden and extraordinary diminution of the atmospheric pressure which is said to take place at the points successively passed over by a tornado, causing the doors and windows of buildings to burst outwards, seems to afford strong confirmation of a violent whirling motion; for an effect of this kind is necessarily due to the centrifugal and upward force of the vorticular action in the interior portion of the whirlwind. There are no other means known by which such an abstraction of pressure can be effected in the open air. An increase of calorific elasticity, if such were produced, either generally or locally, would not greatly disturb the equillibrium of pressure, being resisted by the surrounding and incumbent weight of the entire atmosphere. Besides, the immediate effect of such increased elasticity might rather be to burst *inward* the windows and doors of buildings exposed to its action.

Some of the more important indications mentioned above appear also from an examination of Prof. Bache's observations; although the latter be not definitely located by him, as regards the extreme borders of the track. Thus, in Fig. 7, of Professor Bache's paper, assuming the course as the tornado to be east, and rejecting a few observations near the centre, to avoid error, we find in twenty observations on the right side of the track, a mean inward inclination of 64 degrees, and for nine observations on the left side, a mean inclination, reckoned inward and backward from the course, of 104 degrees, being 14 degrees backward.

It is stated by Prof. Bache, "that the trees lying perpendicular to the track of the storm, are not those furthest from the centre of that track." This generalization accords with my own observations; but can hardly be reconciled with an inward non-whirling motion in the tornado.

It may appear to some, that in the case of a whirlwind the greater portion of the prostrations on the reverse side of the axis should be found in backward direction; and so they would undoubtedly be found, were it not for the inward and the progressive action. But the force is here so far lessened by the reverse action above noticed, that in most cases only a small portion of the trees exposed will be thus prostrated; while the greatest force of the whirlwind, on this side, is felt near its last or closing portion and towards the apparent axis, where the inward, together with the rotative and progressive forces, seem to combine their influence in the closing rush towards the heart of the receding vortex. This appears to account for the nearly opposite directions of prostration found on this side, and it is apparently by this more violent closing action, that many trees which were first overthrown in a direction nearly across the centre of the path, were again moved from their position, or swept onward nearly in the course of the tornado. It is proper to remark here, that an attentive examination of these effects has served to convince me that on the right and more central portions of the track the prostrations for the most part take place either at the outset or under the middle portions of the whirlwind; while on the left or reverse side, up to the line of the apparent axis, and

even across the latter, they occur chiefly under the closing action of the whirl, as above described. The violent effects of this central and closing action are more clearly seen as we advance from the left-hand margin towards the centre or apparent axis of the path.

From the causes to which I have just alluded, the effects are usually more violent on and near the line passed over by the axis, than in other portions of the track. This line of greatest violence is found to coincide nearly with the line which separates the inwardly inclined prostrations of the twe opposite sides of the track.* The latter line or apparent axis of the track is sometimes called the line of convergence, and is indicated on the figure by the line and arrow *c c*. Along this line, from the causes just mentioned, aided also by the elevating forces about the axis, many of the trees are swept onward, and left with their tops in a direction nearly parallel to the course of the tornado; forming an apparent, but not a just exception, to the more lateral direction which pertains to most of the trees prostrated by the onset of the whirlwind, near the central portions of the track. Indeed, the central or closing violence of the advancing whirl is here so great, that the trees are not unfrequently torn out of the ground and carried onward to considerable distances.

It is proper to state here, that in the tracks of all the tornadoes which I have had opportunity to examine, and in some, at least, of those examined by others, the course of rotation has been found the same as in the case before us.†

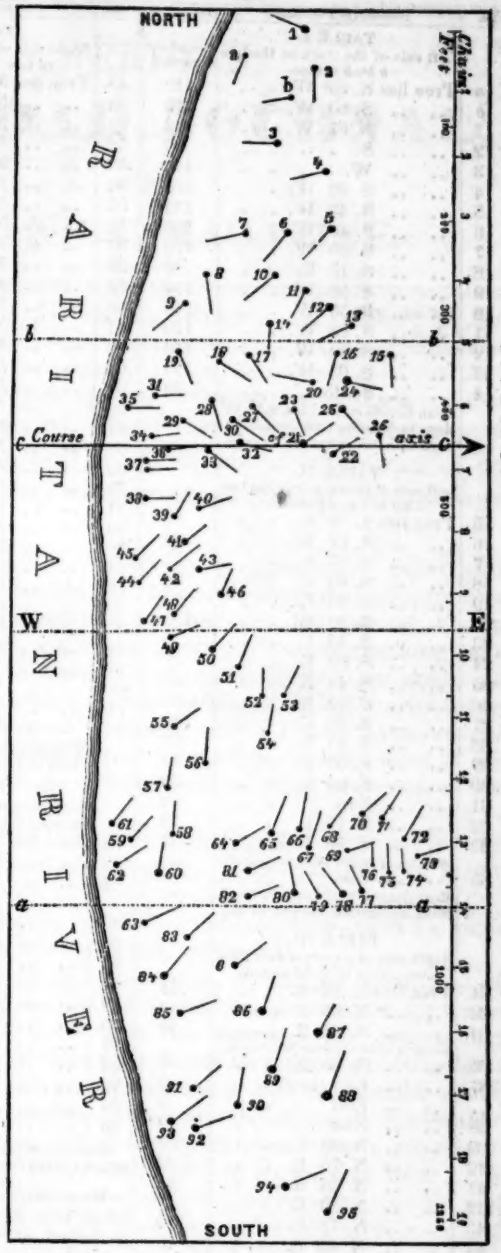
In order to make a just and satisfactory examination of the effects of a tornado, it appears necessary to select portions of the track where the extension of wood or single trees, on each side, is found sufficient to mark clearly the exterior limits of the prostrating power, and where the effects on both sides of the axis are also clearly developed. Our next care should be to ascertain, as near as may be practicable, the line which separates the opposite convergence of the two sides, noticed above as the axis or line of convergence. We should then determine the general direction of this line and of the track at the place examined; which being done, we may proceed to measure the distance to which the prostrations are extended on each side, and then carefully to take the position and direction of prostration of each and of all of the fallen bodies, nothing with care, also, any other phenomena which may serve to aid our inquiries. We may thus obtain valuable materials for future analysis; and this course of investigation, if faithfully pursued, will, it is believed, remove all reasonable doubt of the rotative action of these tornadoes. An examination of their probable origin, and the causes of their enduring activity and violence, belongs not to the present occasion.

New York, 5th February, 1841.

* The line of greatest violence, for the most part, is found somewhat to the right of the line of convergence.

† As in the tornado which passed through Allegany county, New York, July 25th, 1838; described by Mr. Gaylord in the American Journal of Science, vol. xxxvii, p. 92.

NEW-BRUNSWICK TORNADO. *(Plate F.)*



Sketch of the Prostrations found on a section of the Track of the Tornado of June 19, 1835, on the bank of the Raritan, opposite the City of New Brunswick, in the State of New-Jersey.

Explanations.—The east bank of the river is here covered with a belt of wood; the latter having a very irregular outline on the east, where it is bounded by a clear field. The line *c c* represents the apparent course of the axis of the tornado: W. west, E. east. The large dots on the several figures show the root ends of the trees, which were chiefly a species of cedar. In all these cases of prostration, part of the roots were still fast in the ground. Course of the tornado east. The approximate positions of the several trees are in many cases slightly changed in the sketch, for the purpose of a distinct exhibition of each.

Note.—This bank of the river is intersected by small ravines with wooded margins, one of which is nearly opposite to chain 5, and another is near chain 13, and which cause most of the irregularity in the wooded outline.

SCHEDULE OF THE PROSTRATIONS

Observed on a Section of the Track of the New-Brunswick Tornado, of June 19th, 1835.

No.	Direction of Prostration.	Inclination.
	TABLE I. Left side of the track to the line *b b*—5 chains.	Inward and backward.
a	Tree lies S. 20° W. . .	110°
b	.. .. S. 80 W. . .	170
1	.. .. N. 67 W. . .	203
2	.. .. S.	90
3	.. .. W.	180
4	.. .. S. 80 W. . .	170
5	.. .. S. 40 W. . .	130
6	.. .. S. 40 W. . .	130
7	.. .. S. 80 W. . .	170
8	.. .. S. 10 E. . .	80
9	.. .. S. 50 W. . .	140
10	.. .. S. 50 W. . .	140
11	.. .. S. 26 W. . .	116
12	.. .. S. 50 W. . .	140
13	.. .. S. 65 W. . .	155
14	.. .. South . . .	90
	Mean direction, 16 cases, S. 48° W. Mean inclination from course, inward and backward, 138 degrees.	
	TABLE II. Left side of the axis, from the line *b b* to *c c*—1½ chains.	
15	Tree lies S. 2° E. . .	88
16	.. .. S. 12 W. . .	102
17	.. .. S 35 E. . .	55
18	.. .. S. 62 E. . .	28
19	.. .. S. 25 E. . .	65
20	.. .. N. 80 W. . .	190
23	.. .. S. 20 E. . .	70
24	.. .. S. 80 E. . .	10
25	.. .. S. 45 E. . .	45
26	.. .. S. 10 E. . .	80
27	.. .. S. 45 E. . .	45
28	.. .. S. 20 E. . .	70
29	.. .. S. 60 E. . .	30
30	.. .. S 60 E. . .	30
31	.. .. East. . . .	00
32	.. .. S. 75 E. . .	15
33	.. .. S. 56 E. [Included as belonging by its inclination to this table.]	34
35	.. .. East . . .	00
	Mean direction, 18 cases, S. 37° E. Mean inclination inward, 53 deg.	
	TABLE III. Right side of apparent axis from line *c c* to W E—3 chains.	
21	Tree lies N. 56° E. . .	34
22	.. .. N. 60 E. . .	30
34	.. .. N. 80 E. [Included as belonging by its inclination to this table.]	10
36	.. .. N. 85 E. . .	5
37	.. .. East (two) . .	0
..	.. .. East . . .	0
38	.. .. East . . .	0
39	.. .. N. 30 E. . .	60
40	.. .. N. 70 E. . .	20
41	.. .. N. 55 E. . .	35
42	.. .. N. 50 E. . .	40
43	.. .. N. 78 E. . .	12
44	.. .. N. 45 E. . .	45
45	.. .. N. 45 E. . .	45
46	.. .. N. 25 E. . .	65
47	.. .. N. 35 E. . .	55
48	.. .. N. 40 E. . .	50
	Mean direction, 17 cases, N. 60° E. Mean inclination inward, 30 deg.	

No.	Direction of Prostration.	Inclination.
	TABLE IV. Right side of axis, from line W E to line *a a*—4½ chains.	Inward and backward.
49	Tree lies N. 67° E. . .	23°
50	.. .. N. 45 E. . .	45
51	.. .. N. 22 E. . .	68
52	.. .. N. 3 E. . .	87
53	.. .. N. 30 E. . .	60
54	.. .. N. 10 E. . .	80
55	.. .. N. 35 E. . .	55
56	.. .. North . . .	90
57	.. .. N. 10 E. . .	80
58	.. .. N. 3 E. . .	87
59	.. .. N. 45 E. . .	45
60	.. .. N. 10 E. . .	80
61	.. .. N. 35 E. . .	55
62	.. .. N. 60 E. . .	30
64	.. .. N. 40 E. . .	50
65	.. .. N. 20 E. . .	70
66	.. .. N. 10 E. . .	80
67	.. .. N. 20 E. . .	70
68	.. .. N. 40 E. . .	50
69	.. .. N. 70 E. . .	20
70	.. .. N. 50 E. . .	40
71	.. .. N. 35 E. . .	55
72	.. .. N. 30 E. . .	60
73	.. .. N. 50 E. . .	40
74	.. .. North (two) .	90
75	.. .. North " .	90
76	.. .. North " .	90
77	.. .. N. 20 W. (clump of 3)	110
78	.. .. N. 35 W. . .	125
79	.. .. N. 30 W. . .	120
80	.. .. N. 10 W. . .	100
81	.. .. N. 65 E. . .	25
82	.. .. N. 70 E. . .	20
	Mean direction, 33 cases, N. 24° E. Mean inclination, 66 degrees.	
	TABLE V. Right side of track, from line *a a* to outward limit of prostration—5 ch.	
63	Tree lies N. 65° E. . .	25
83	.. .. N. 45 E. . .	45
84	.. .. N. 40 E. . .	50
e	.. .. N. 55 E. . .	35
85	.. .. N. 70 E. . .	20
86	.. .. N. 23 E. . .	67
87	.. .. N. 31 E. . .	59
88	.. .. N. 20 E. . .	70
89	.. .. N. 22 E. . .	68
90	.. .. N. 10 E. . .	80
91	.. .. N. 55 E. . .	35
92	.. .. N. 70 E. . .	20
93	.. .. N. 55 E. . .	35
94	.. .. N. 68 E. . .	22
95	.. .. N. 25 E. . .	65
	Mean direction, 15 cases, N. 44° E. Mean inclination inward from course of tornado, 46°.	

Mean direction of all the prostrations on *left* of axis, 34 cases, S. 3° W.—being 3° backward, or 93° inward and backward.

Mean direction on *right* of axis, 65 cases, N. 38° E.—being 52° inward from course.

Difference of mean inclination on the two sides, 41 degrees.

Difference of opposite marginal sections (Tables I and V) 92 degrees.